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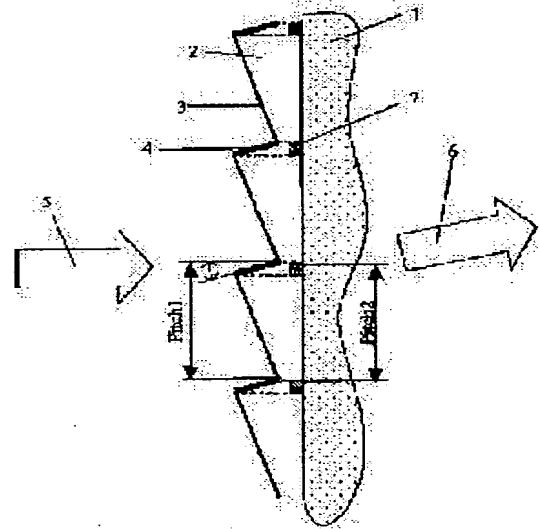
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(54) DIFFRACTION OPTICAL DEVICE AND OPTICAL SYSTEM HAVING THE SAME, PHOTOGRAPHING DEVICE AND OBSERVATION DEVICE**(57)Abstract:**

PROBLEM TO BE SOLVED: To provide a diffraction optical device to decrease the quantity of flare which degrades the optical performance, and to provide an optical system, a photographing device and an observation device having the above diffraction optical device.

SOLUTION: A light-shielding means is formed which shields the light entering the edge part of a diffraction grating or the light exiting from the edge part.

**LEGAL STATUS**

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CLAIMS

[Claim(s)]

[Claim 1] The diffraction optical element characterized by having a shading means to shade the light injected from the light which carries out incidence to the edge section of a diffraction grating, or the edge section concerned.

[Claim 2] The diffraction optical element according to claim 1 characterized by preparing the aforementioned shading means in the optical incidence side of the aforementioned diffraction grating, and shading the incident light to this diffraction grating.

[Claim 3] The diffraction optical element according to claim 1 characterized by preparing the aforementioned shading means in the irradiation appearance side of the aforementioned diffraction grating, and shading the injection light from this diffraction grating.

[Claim 4] A diffraction optical element given in any 1 term of the claims 1-3 to which the aforementioned shading section is characterized by having a diffraction operation.

[Claim 5] the aforementioned shading means — the lattice pitch of the aforementioned diffraction grating, and abbreviation — a diffraction optical element given in any 1 term of the claims 1-4 characterized by having two or more shading sections put in order in the same pitch

[Claim 6] The aforementioned diffraction grating is a diffraction optical element given in any 1 term of the claims 1-5 characterized by carrying out the laminating of two or more diffraction gratings which consist of material from which at least two-kind distribution differs, and changing.

[Claim 7] Optical system characterized by having the diffraction optical element of a publication in any 1 term of claims 1-6.

[Claim 8] Photography equipment characterized by having optical system according to claim 7.

[Claim 9] Observation equipment characterized by having optical system according to claim 7.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the optical system which has a diffraction optical element and this diffraction optical element, photography equipment, and observation equipment.

[0002]

[Description of the Prior Art] As the diffraction optical element (diffraction lens) constituted as a diffraction optical element so that it might have for example, a lens operation is shown below, having from the former the feature which is not in a certain refractive lens is known.

** since an aspheric surface wave is easily generable -- aberration -- effective -- an amendment -- things are made

** Since it does not have thickness substantially, the flexibility of a design is high and compact optical system can be realized.

** since the amount equivalent to the Abbe number in a refractive lens serves as a negative value with a diffraction lens -- combination with a refraction element -- chromatic aberration -- effective -- an amendment -- things are made

[0003] The feature of such a diffraction lens is used and raising the performance of optical system is described in detail by Binary Report 854, MIT Lincoln Laboratory, and August 1989., for example. Optics Technology; The Theory and Design of Multi-Level Diffractive Optical Element Gary J.Swanson Technical

[0004] As mentioned above, on the other hand, although there are many useful features which are not in the conventional refraction element in a diffraction optical element, in order that diffraction efficiency may be dependent on wavelength, there are the following theoretic problems. For example, although the diffraction optical element applied to optical system is used in many cases as a lens element, generally in such a use, it is not desirable that two or more diffracted lights (two or more foci) exist. then, a base material transparent on the wavelength generally used in the conventional diffraction optical element (specifically diffraction lens) -- a cross section -- a serration -- the relief (it blaze-ized) pattern made wavelike is formed, and it is made to centralize energy on the diffracted light of a specific degree

[0005] Since the wavelength which can concentrate energy depending on the channel depth, i.e., the wavelength from which diffraction efficiency becomes the maximum, differs in case a cross section is processed into a serration sinuate, as described above, it becomes impossible by the way, to cover the full wave length band of the light which has wavelength width of face, and to centralize energy on the diffracted light of a specific degree. Although such a phenomenon does not become a problem in the case of optical system using the homogeneous light like a laser beam, when diffraction efficiency is optimized with the light of specific wavelength, with the optical system which uses the white light like a camera, there is a problem that diffraction efficiency will fall on other wavelength.

[0006] Therefore, the structure of the wavelength dependency of diffraction efficiency which was mentioned above is examined in detail, and JP,9-127321,A, JP,9-127322,A, JP,9-325203,A, JP,11-044808,A, JP,11-044810,A, JP,11-064616,A, JP,11-084118,A, JP,11-223717,A, etc. propose the relief type diffraction optical element new type which reduced the wavelength dependency of diffraction efficiency. These diffraction optical elements combine the optical material of two kinds from which distribution and a refractive index differ, or the kind beyond it, and form in the interface of the different optical material the relief pattern which accomplishes a blazed mold diffraction grating.

[0007]

[Problem(s) to be Solved by the Invention] However, in the diffraction optical element which has the blazed mold diffraction grating which processed the cross section into the serration sinuate, the problem on processing and the problem of there being a beam of light which does not carry out incidence in parallel with the edge section of a relief pattern from the restrictions on arrangement of optical system, and this beam of light passing the edge section, serving as flare light, reaching the image surface, and worsening the optical-character ability of an element or optical system arise. Although optical-character ability is not worsened like drawing 4 when light is carrying out incidence in parallel to the edge section 41, that is, like drawing 5 On account of processing of the mold which forms a relief pattern, the edge section 41 does not stand perpendicularly, or When an incident light carries out incidence aslant to a blazed mold diffraction grating like drawing 6, it will have a certain angle and the amount of the light which passes the edge section 41 increases, it serves as flare light and the edge section 41 and an incident light make optical-character ability get worse.

[0008] Then, this invention aims at offering the optical system which has the diffraction optical element which can decrease the amount of the flare light which worsens optical-character ability, and this diffraction optical element, photography equipment, and observation equipment.

[0009]

[Means for Solving the Problem] this invention offers the optical system which has the diffraction optical element constituted like following (1) - (9), and this diffraction optical element, photography equipment, and observation equipment in order to attain the above-mentioned technical problem.

(1) The diffraction optical element characterized by having a shading means to shade the light which carries out outgoing radiation from the light which carries out incidence to the edge section of a diffraction grating, or the edge section concerned.

(2) A diffraction optical element given in the above (1) characterized by preparing the aforementioned shading means in the optical incidence side of the aforementioned diffraction grating, and shading the incident light to this diffraction grating.

(3) A diffraction optical element given in the above (1) characterized by preparing the aforementioned shading means in the irradiation appearance side of the aforementioned diffraction grating, and shading the injection light from this diffraction grating.

(4) A diffraction optical element given in either of above-mentioned (1) - (3) to which the aforementioned shading section is characterized by having a diffraction operation.

(5) A diffraction optical element with the aforementioned shading means given in the lattice pitch of the aforementioned diffraction grating, and either of abbreviation above-mentioned [which is characterized by having two or more shading sections located in a line in the same pitch] (1) - (4).

(6) the above -- a diffraction grating -- at least -- two -- a kind -- distribution -- differing -- material -- from -- becoming -- plurality -- a diffraction grating -- a laminating -- carrying out -- changing -- things -- the feature -- ** -- carrying out -- the above -- (-- one --) - (-- five --) -- either -- a publication -- diffraction -- an optical element .

(7) The above (1) Optical system characterized by having the diffraction optical element of a publication in either of - (6).

(8) Photography equipment characterized by having the optical system of a publication in the above (7).

(9) Observation equipment characterized by having the optical system of a publication in the above (7).

[0010]

[Embodiments of the Invention] In the blazed mold diffraction optical element which applied the above-mentioned composition, for example, processed the cross section into the serration sinuate in the form of operation of this invention [when light does not carry out incidence in parallel with the edge section of a relief pattern which accomplishes a blazed mold diffraction grating from the restrictions on the problem on processing, and arrangement of optical system] It becomes possible to realize the diffraction optical element of making it get worse, so that the light which went to the edge section turns into flare light and cannot disregard optical-character ability.

[0011]

[Example] Below, the example of this invention is explained.

[Example 1] drawing 1 is the cross section showing the composition in the example 1 of this invention. For the relief pattern side (diffraction side) of a diffraction grating 2, and 4, as for an incident light and 6, in this drawing, the edge section of a diffraction grating and 5 are [the ** material member from which 1 becomes the base of a diffraction optical element the synthetic-resin member in which 2 forms a blazed mold diffraction grating, and 3 / injection light and 7] the shading sections. the shading section 7 -- photo lithography etc. -- the ** material member 1 top of the base (substrate) -- shading material, such as optical-absorption material, light reflex material, etc., such as chrome plating, -- forming -- the lattice pitch of the above-mentioned relief pattern, and abbreviation -- it has stood in a line at the same interval (pitch), and is functioning as a diffraction element by itself Moreover, the formation method of the shading section is good also by meanses, such as printing and vacuum evaporation. Width of face of the shading section was made into the width of face which projected the incident light to an edge on the ** material member 1 as it was. Moreover, what is necessary is just to fabricate a relief pattern by injection molding with a mold, and replica fabrication.

[0012] Although an incident light 5 is injected with a desired angle according to the relief side 3 as shown in drawing 1 , it is shaded by the shading section 7, and the light which penetrated the edge section 4 does not arrive at an image formation side, but it becomes possible to prevent quality-of-image degradation.

[0013] [Example 2] drawing 2 is the cross section showing the composition in the example 2 of this invention. Since it is shading before it arranges the shading section 7 to an incident-light side and light diffuses in the edge section from a relief side, it becomes possible to shade more effectively.

[0014] [Example 3] drawing 3 is the cross section showing the composition of the example 3 of this invention. In the laminating relief type diffraction optical element using two different synthetic-resin material, since it is shading before it arranges the shading section 7 to an incident-light side and light diffuses in the edge section from a relief side, it becomes possible to shade more effectively.

[0015] In the [example 4] examples 1-3, although two or more shading sections 7 which are shading meanses are placed on the base (diffraction-grating substrate) 1, this example 4 is a form which forms each shading section on each edge section 4 of a diffraction grating 2. The material of the shading section is the same as the above-mentioned examples 1-3.

[0016] Although the example explained above is aimed at the light (for example, 400nm - 700nm) of a wide band

as a light which carries out incidence to the optical system which has a diffraction optical element and it, according to this invention, optical system which has the diffraction optical element and it in which the infrared radiation and ultraviolet rays of the light of a narrow-band, a narrow-band, or a wide band carry out incidence can also be carried out. Furthermore, as a cross-section configuration of a blazed mold diffraction grating, it is the thing of the configuration which approximated not only the thing of a serration but this serration on the stairway, and this invention can be applied also to an optical element (binary optics) with such a stair-like cross-section configuration. Furthermore, as an optical element, this invention is applicable to a penetrated type thing, a reflected type thing, and both. Moreover, the optical element of a various form explained above can be used for the various optical system of projection equipments, such as various optical system of observation equipments, such as various optical system of photography equipments, such as a camera, a binocular, and a microscope, a liquid crystal projector, and a stepper.

[0017]

[Effect of the Invention] As explained above, according to this invention, the light which passes the edge section of a diffraction grating serves as the flare, and the optical system which has the diffraction optical element which does not not much worsen optical-character ability, and this diffraction optical element, photography equipment, and observation equipment can be realized.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The cross section showing the composition of the example 1 of this invention.

[Drawing 2] The cross section showing the composition of the example 2 of this invention.

[Drawing 3] The cross section showing the composition of the example 3 of this invention.

[Drawing 4] The cross section showing the composition of the conventional example.

[Drawing 5] The cross section showing the composition of the conventional example.

[Drawing 6] The cross section showing the composition of the conventional example.

[Description of Notations]

1: The ** material member used as the base of a blazed mold diffraction grating

2: the synthetic resin which forms a blazed mold diffraction grating -- a member

3: Relief pattern side

4: Edge section

5: Incident light

6: Injection light

7: Shading section

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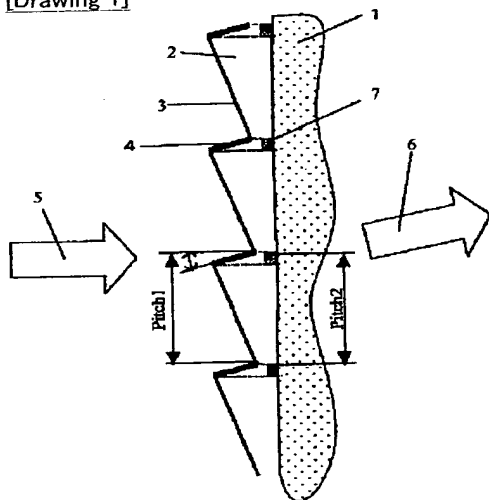
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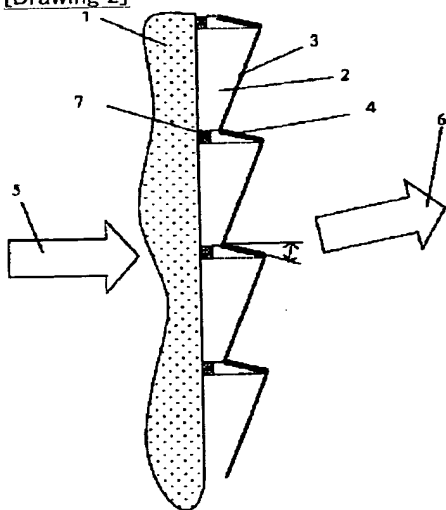
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DRAWINGS

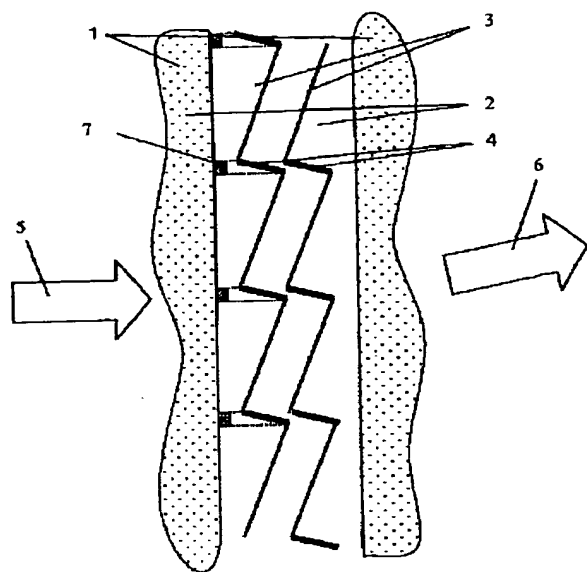
[Drawing 1]



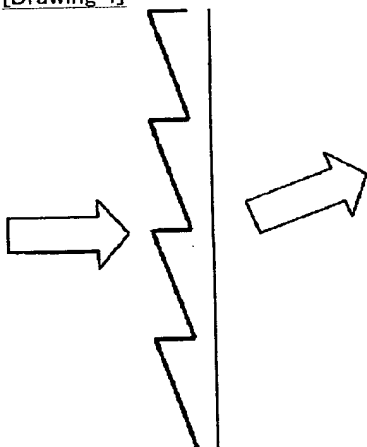
[Drawing 2]



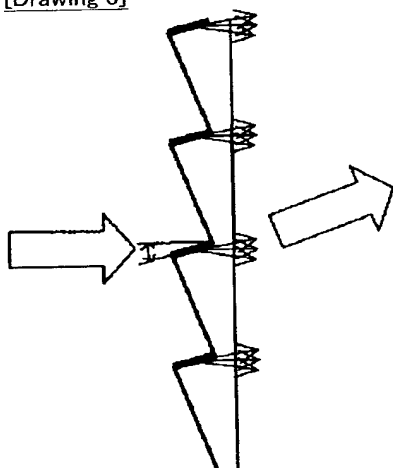
[Drawing 3]



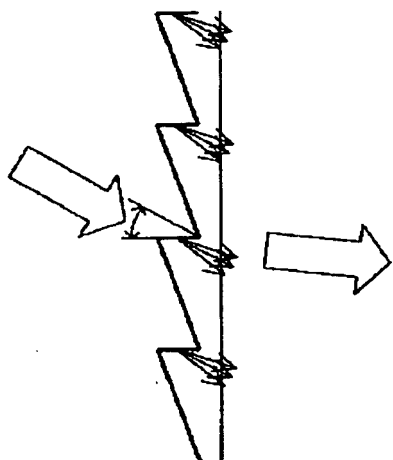
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]